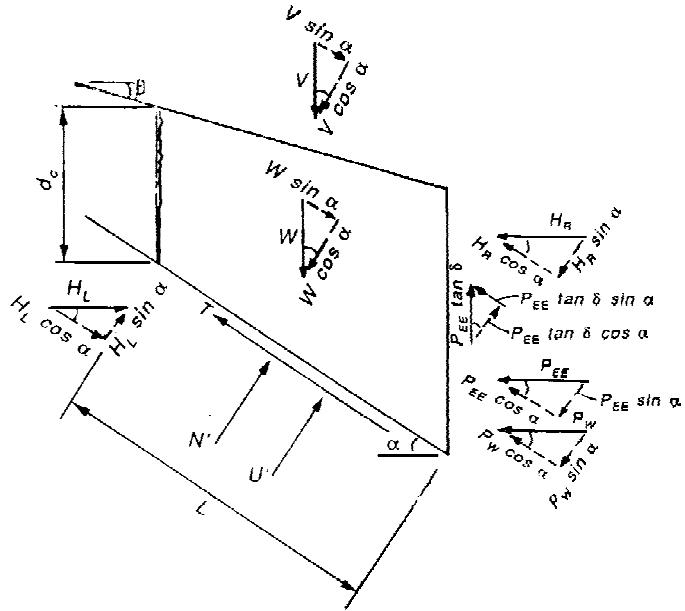


DERIVATION OF GENERAL WEDGE EQUATION FOR SINGLE WEDGE ANALYSIS
INCLUDING THE EFFECT OF WALL FRICTION (δ)

1. Effective Horizontal Earth Force. Given the following driving wedge which possesses both a c and a ϕ , an equation for P_{EE} , the horizontal effective earth force, will be derived.



Summing forces normal to the slip plane yields,

$$H_L \sin \alpha + U + N' - V \cos \alpha - H_R \sin \alpha + P_{EE} \tan \delta \cos \alpha - P_{EE} \sin \alpha - W \cos \alpha - P_w \sin \alpha = 0$$

Solving for N' yields,

$$N' = (H_R + P_{EE} + P_w - H_L) \sin \alpha + (V + W - P_{EE} \tan \delta) \cos \alpha - U = 0 \quad (1)$$

Summing forces tangent to the slip plane yields,

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$$H_L \cos \alpha - T + V \sin \alpha + W \sin \alpha - H_R \cos \alpha - P_{EE} \tan \delta \sin \alpha - P_{EE} \cos \alpha - P_w \cos \alpha = 0$$

Solving for T yields,

$$T = (H_L - H_R - P_{EE} - P_w) \cos \alpha + (V + W - P_{EE} \tan \delta) \sin \alpha \quad (2)$$

According to the Mohr-Coulomb failure criterion,

$$T = N' \tan \phi + cL \quad (3)$$

Inserting Equations 1 and 2 into Equation 3 yields,

$$(H_L - H_R - P_{EE} - P_w) \cos \alpha + (V + W - P_{EE} \tan \delta) \sin \alpha \\ = [(H_R + P_{EE} + P_w - H_L) \sin \alpha + (V + W - P_{EE} \tan \delta) \cos \alpha - U] \tan \phi + cL$$

Simplifying and solving for P_{EE} yields,

$$P_{EE} = \frac{(W + V)(\sin \alpha - \cos \alpha \tan \phi) + (H_L - H_R - P_w)(\cos \alpha + \sin \alpha \tan \phi) + U \tan \phi - cL}{\sin \alpha \tan \phi + \sin \alpha \tan \delta + \cos \alpha - \cos \alpha \tan \delta \tan \phi} \quad (4)$$

$$P_{EE} = \frac{(W + V)(\tan \alpha - \tan \phi) + (H_L - H_R - P_w)(1 + \tan \alpha \tan \phi) + \frac{U \tan \phi}{\cos \alpha} - \frac{cL}{\cos \alpha}}{1 + \tan \alpha \tan \phi + \tan \delta (\tan \alpha - \tan \phi)}$$

The total effective earth force acts at an angle δ with respect to the horizontal. The total effective earth force is defined as

$$P = \frac{P_{EE}}{\cos \delta}$$

2. Soil Parameters. The horizontal effective earth force for a particular SMF can be calculated by inserting the factored soil parameters ϕ_d and c_d into Equation 5. This yields,

$$P_{EE} = \frac{(W + V)(\tan \alpha - \tan \phi_d) + (H_L - H_R - P_w)(1 + \tan \alpha \tan \phi_d) + \frac{U \tan \phi_d}{\cos \alpha} - \frac{c_d L}{\cos \alpha}}{1 + \tan \alpha \tan \phi_d + \tan \delta (\tan \alpha - \tan \phi_d)} \quad (5)$$